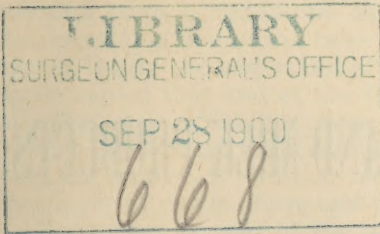


*Vaughan.*



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BACTERIAL POISONS IN MILK AND MILK PRODUCTS,

BY

PROF. V. C. VAUGHAN, M. D.,

DIRECTOR OF STATE LABORATORY OF HYGIENE, ANN ARBOR, MICHIGAN.

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BY PROF. V. C. VAUGHAN, M. D., DIRECTOR OF STATE LABORATORY OF  
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*Mr. President, Gentlemen*—I am not going to read a paper today, but am going to give you a talk which I hope will be practical. I have made the statement elsewhere that milk is one of the deadly drinks. I want to tell you this afternoon wherein and for what reasons it is deadly. Dr. Baker will give us a paper soon on Infantile Mortality, but I think he will pardon me for making the statement just now that one-fourth of all the children born to the civilized world die before they reach five years of age, and that about one-half of these deaths are due to intestinal disturbances, and these intestinal disturbances are cases of milk poisoning. Therefore, about one-eighth of all the children born into this world die before they are five years of age from the effects of impure milk. Now am I not right when I say that milk is a deadly drink? In making this statement I do not take into consideration at all the large number—I do not know how many—of persons over five years of age who drink milk containing germs, such as the germ of tuberculosis, for instance.

We may divide the germs that are found in milk into two classes: (1) Those that are in the milk when it comes from the udder of the cow, and (2) those that find their way into the milk after it is drawn. The perfectly healthy cow's milk is germ free. I have about the laboratory here somewhere—I might have looked up the tubes—samples of milk that I



drew from a cow in 1888. I sterilized the tubes, then went out to milk the cow, carrying with me an alcohol lamp and a solution of bichloride of mercury, and I disinfected the exterior of the udder carefully, then in the alcohol lamp I heated one end of each tube and with a pair of forceps broke off that end of the tube. As soon as it was sufficiently cool I introduced it into the udder and allowed it to fill with milk, and then immediately sealed that end of the tube again, the other end remaining sealed all the while. The last time I looked at these tubes—I say they were drawn in 1888, the last time I looked at them was in 1894, when the milk had not soured, it had not coagulated, it was just as it was at first with the layer of cream above and the unsoured milk below.

Now what is said of the milk of the cow is true of the milk of the healthy mother. It is practically germ free. Absolutely germ free if the mother is in good health. This is the chief reason why children fed exclusively from the breast of the mother do not have these diarrhœal disturbances of which I spoke a moment ago. They are practically unknown among those children taking their food exclusively from the breast of the healthy mother. It is not because the child cannot digest the milk of the cow that so many artificially fed children die, it is not because there are slight chemical differences between the milk of the cow and the milk of woman, it is because in the artificially fed child the milk becomes poisonous. That is it.

Now remember I have divided the germs into those in the milk when drawn and those which find their way into the milk after it has been drawn or in the process of milking. For the present at least I am not going to say anything about the first class of germs that I have mentioned here, those that are in the milk in the cow. I am going to discuss those germs and those bacterial poisons which arise from the contamination of the milk during the milking or after the milking.

We may divide these germs again into specific germs and non-specific germs. For instance, if the milkman dilutes his milk with water containing typhoid germs, then that milk supply may spread typhoid fever. In that case a specific germ, a germ capable of producing a definite disease has been added to the milk, and the milk becomes poisonous for this reason. Dr. Christian, of Wyandotte, sent us some years ago a sample of water from the well of a milk man, and some of the milk from the cans of the milk man, and he told us that the typhoid fever in Wyandotte followed this milk man's wagon, that typhoid fever was in nearly every family taking milk from this man, and that there were no other cases in the town. We found the same germ in the water and in the milk. There was evidently some connection, directly or indirectly, probably indirectly, between the udder of that man's cows and the well. This is a case of specific infection of the milk after it is drawn. In addition to the typhoid germ we might have specific infection of the milk with diphtheria, possibly with scarlet fever, possibly with small-pox, or with any of the specific diseases. The germs of these specific diseases may get into the milk after it is drawn, and then the milk might be used as a vehicle for spreading any specific disease. But I am not going to discuss that class of germs found in milk. I am going to tell you about the non-specific germs, the toxicogenic germs as we call them here, the poison-producing germs, that do not produce typhoid fever, nor scarlet fever, nor measles, nor whooping-cough, but which do produce poisons.



Now Dr. Novy has in his very admirable paper told you all about or a great deal about the toxins, and told it well. I want to sum up one of his statements to show that the difference between the germ and its toxin is one of degree and not one of kind. In the germ we have a poison which is capable of multiplying. We have a living, growing poison, it is a poison, a chemical poison, but a growing poison, one capable under suitable conditions of indefinite multiplication. In the toxin we have the same poison exactly, just as deadly if we could get it in the same amount, but it is no longer capable of multiplying, and it is a difference in degree rather than kind. The germ is the living poison; the toxin is the dead poison, and by the distinction here between life and death I mean that the one is capable of multiplication, and the other is not capable of multiplication. That is all. Otherwise they are the same.

Now there are a great many germs, no man knows how many there are, that grow readily in milk and produce poisons. A number of years ago two acquaintances and friends of mine started out to find the specific germs that were supposed to grow in milk and produce the poisons causing the summer diarrhoeas of infancy. These men were Dr. Booker of Baltimore and Dr. Escherich of Munich. Booker isolated as many as thirty germs found in the stools and intestines of children suffering from the summer diarrhoea, many of which produced poisons in milk, and Escherich isolated quite as many more. How many remain undiscovered as yet, no man can tell.

Now I want to make this talk just as practical as it is possible to make it, and I want to give the conditions under which milk must be drawn and kept in order to prevent its being poisonous. Of course we must have healthy cows to start with. When we had the Convention here two years ago I introduced a resolution and it was approved by the Conference, asking the legislature to pass an enactment forbidding the sale of milk by any save those licensed to sell it, and that these licenses should be granted only after an inspection or test of the milk by the Sanitary Live Stock Commission.

We should have healthy animals to start with, and then they should be properly fed and stabled. The udders of the cows should be washed before the milking, and what is of quite as much importance the hands of the milker should be washed occasionally as well. The receptacle into which the milk is drawn should be washed and should be sterilized. After the milk has been drawn from washed udders with clean hands into sterilized vessels or into clean vessels—at least, I do not know that it is necessary to sterilize them if they are clean,—then the milk must be rapidly cooled. These poison-producing germs do not grow at a temperature below 50° Fah. That is one thing we know about them. The milk must be lowered to that temperature or lower as quickly as possible. Now let me say right here parenthetically that it has been known of course from time immemorial that the great and appalling death rate among children grows in the summer time. The British Medical Association, the American Medical Association, the Association of German Physicians, and other learned bodies had appointed committees which had made report after report to ascertain why it was that these diarrhoeas existed in the summer time and not in the winter time, and every available reason for it has been given. Phy-



sicians tried to find cause for the infantile diarrhœas in the sun spots, in the position of the moon as to whether it hung high or low, and I have honestly heard a paper read before the International Medical Association when it met in Washington in 1887 in which it was suggested that the infantile diarrhœas were in part at least, and in a large part, caused by the use of baby carriages. The argument the man gave was unanswerable. He said that the summer diarrhœas of infancy had increased fearfully since baby carriages had been introduced. You cannot deny that. It is true. Therefore the baby carriages caused the summer diarrhœa. This seems too ridiculous. The members of the State Board of Health will remember a similar argument to show that tomatoes caused cancer. I believe some of us answered this argument by saying that umbrellas caused cancer, because since umbrellas had been used cancer had increased.

I want to relate to you a little incident which will illustrate the necessity of taking care of the milk as I have before stated. A little child which has been under my care ever since its birth had to be fed artificially. I had directed the selection and care of the milk. The father bought a cow which was proved to be healthy, the cow was well pastured and well stabled, but the milk man was not quite as clean as he should have been. The milk fed to the child was sterilized. About two weeks ago the child very suddenly developed a fearful diarrhœa, and was in a dangerous condition, although it was drinking this sterilized milk. Upon close inquiry the cause for it was found to be this: The milk man came very early in the morning, the exact hour depending somewhat upon his own pleasure. He sometimes came about five o'clock in the morning, drew the milk and placed it in the kitchen, where it stood until the girl was ready to attend to it. It stood there from five o'clock until eight sometimes before the girl got around to it to put the milk in the ice chest, and there was enough chemical poison produced in the milk during the three hours to poison the child. The milk was then taken and sterilized and fed to the child. We found in this milk a germ which undoubtedly came from the feces of the cow, some of the fecal matter getting in or blowing in when the milking was being done, and within the three hours from five to eight o'clock in the morning enough poison generated in the milk to jeopardize the life of that child. When the milk was sterilized afterwards the germs were killed but the poisons were not destroyed. Of course if the germs had not been killed the child probably would have died. Illustrations of this kind I might multiply quite indefinitely.

Possibly some of you remember that in the first ice cream in which we found the poison tyrotoxicon that the poison originated in practically the same way. It occurred in the village of Lawton, in the western part of this State, where the milk was drawn from healthy cows, was brought into the village, divided into two portions, one portion was flavored with lemon, was frozen immediately and served at a church festival and was not poisonous; the other portion was flavored with vanilla, was allowed to stand in a very filthy room for three or four hours before it was frozen, then it was frozen and served. A teaspoonful of that ice cream was sufficient to produce nausea and vomiting in an adult. Of course they said in this case that the poison was in the vanilla, because one cream was



flavored with lemon and the other with vanilla, and the lemon cream did not hurt anyone. Fortunately there was some of the vanilla flavoring left, and Dr. Novy and I after drinking it came to the conclusion that it did not produce any injurious effect whatever. Another very striking illustration was that which occurred at Long Branch, where the milk was drawn at the very unusual hours of midday and midnight. The milk drawn at midnight was cooled and then carted to Long Branch the next morning. The milk drawn at midday was immediately carted to the village, a distance of eight miles, in the hot month of August, and some hundreds of persons were poisoned with it. Here the milk came from the same cows, at different times of the day, all the difference being in the conditions under which the milk was kept.

Now the number of germs, as I have stated, which may make milk poisonous is quite unlimited. A few of these germs we have isolated. I have here one of the milk germs which is capable of changing milk so that it becomes very highly poisonous. This germ was obtained first from some ice cream which was sent us about a year ago from a village in the northern part of this State. About 150 people ate of the ice cream and every one of them was poisoned to a greater or less extent. Some of the ice cream was sent to Mr. Perkins and myself. We went to work with the germ and succeeded in isolating it and studying its habits quite thoroughly. We have subsequently found the same germ in cheese. It produces practically two poisons, neither one of which have we isolated, but one is a basic substance, and the other belongs to the group of toxins that Dr. Novy spoke about. This poison, or these combined poisons (both seem to have practically the same effect), differ quite markedly from the poisons that we have hitherto found in milk. These poisons have a more markedly depressing action upon the heart. They cause nausea, vomiting, purging as most of the other milk-poisons, but in addition to this they cause a very marked depression of the heart. So marked has this been that some of the physicians in attendance were struck with the fact, and one of them wrote me: "I have before seen cases of cheese poisoning, but I have never seen a case where the heart was so remarkably depressed." The action is very much like that of muscarin, the poison which is found in the mushroom. We have studied the conditions under which these germs grow. They grow upon almost every vegetable. We have grown it on beets, turnips, squash, potatoes, bananas, and almost every vegetable and fruit. To my mind this offers an explanation of the danger of keeping decayed fruit in the vicinity of milk. I had a case of milk poisoning here in town not long ago, and I found that the milkman brought the milk in a pail and set it in the cellar. In this cellar were decaying turnips, potatoes, etc. I did not have the time to investigate these vegetables in order to see if this specific germ was present or not.

I told you that Dr. Booker had isolated a large number of germs which he had found in the evacuations of children. He was kind enough to send me some of these germs, and I have obtained the chemical poisons of some of them. I found that all of these germs produce toxins, so-called proteid or albuminous poisons which when injected into kittens and given to young pups produce diarrhœa, exhaustion, and death. There are many interesting things about these poisons, and particularly the effect they have upon some animals as compared with others, and the



effect they have upon different animals at different ages. It would be practically safe for an adult to drink milk that it would be very unsafe for a child to drink. We can demonstrate this in the lower animals. Quantities of this poison will affect pups and young kittens when ten, twenty or thirty times the amount would not affect adult animals of the same species. We found also a great difference in the effects upon rats and cats.

I have already formulated elsewhere the rules for taking care of milk. I want to say something about sterilizing milk. I am not going to touch upon your subject, Prof. Smith, only to say this, that many of the bacterial poisons that are formed in milk are not destroyed by sterilization or pasteurization. We must prevent the formation of the poison before we sterilize or pasteurize the milk.

I think these are the main points that I wanted to present to you. If there are any questions I shall be glad to answer them. The poisons that have been found in milk so far are tyrotoxicon, which is a ptomain or basic substance, and the basic substance which have not been isolated, and a number of toxins or poisonous albuminous substances, probably without limit. We have isolated five or six of the latter in this laboratory. We have separated them from the milk and have poisoned animals with them. The importance of the subject will be appreciated by the statement that I made in the beginning concerning the large death rate in infants. I want to say that since milk has been sterilized and since greater care has been given to milk the death rate among children from the diarrhoeal disorders have been greatly decreased. I thank you.

#### DISCUSSION OF "BACTERIAL POISONS IN MILK AND MILK PRODUCTS."

*Dr. Hurd*—I would like to ask Dr. Vaughan if a cow might obtain any of the specific germs through drinking, and then transmit them to the milk?

*Dr. Vaughan*—That is a question which I do not think anyone can answer at present. A number of experiments have been made, but so far the results have been negative. That is, if you have a healthy cow and give her typhoid germs or diphtheria germs in water, there is no positive evidence that that germ really appears in the milk. The tuberculous germ may come from the tuberculous cow.

*Dr. Rosenberry*—Is sterilization an aid in developing these poisons in milk?

*Dr. Vaughan*—I avoided saying anything about sterilization because Professor Smith is a better authority upon that subject than I am. However, there will be no danger in producing poisons in that way. There is one thing that I would like to say and that is a fact that I do not think is generally appreciated. The complete sterilization of milk at any ordinary temperature is a practical impossibility. That is as it is done for children. There are germs that will stand hours of boiling without being killed, and these germs are frequently present in milk. Now the point I want to make is this: Practically it is just as essential after milk has been sterilized for a child that it should be kept in a cool place until the child takes it, as it is that it should be sterilized.



*Dr. Rosenberry*—Are these germs very frequently present?

*Dr. Vaughan*—I do not know how frequently, but sometimes they are present. Perhaps I made that statement a little too strong. The most thorough work that I know of that has been done upon that subject has been done by . He found these germs present. I do not remember the frequency, but they were present in the milk.

*Prof. Smith*—I would like to ask if all of these germs which are peculiarly resistant to heat do not come in from carelessness or other ways which are readily avoidable?

*Dr. Vaughan*—Yes, and there is another thing: The people must be educated to pay the milk man better prices for his milk. No milk man can supply milk as it should be supplied at the prices that are now paid. If people would pay half the money for good milk that they pay for the worthless and worse than worthless baby foods, we would have a better condition of things. They pay enormous prices for baby foods and expect to jew down the milk man. The milk man can not produce milk with all the necessary precautions and care at the price.

*Prof. Smith*—I would like to ask Dr. Vaughan if he thinks it possible that germs would grow in the milk, where the germ was taken into the stomach through water or other sources?

*Dr. Vaughan*—They would. The germs have been observed to be present and even to grow in sterilized milk, or absolutely pure milk. If the germs are there they will grow. But one more thing. The child or infant has no business to be drinking water that is not sterilized, or taking any other kind of food that is not sterilized.

*Prof. Smith*—I tried the same experiment of drawing milk from the inner part of the udder of the cow, but never reached the success that Dr. Vaughan has. It seems to me simply amazing how long milk will keep sweet if drawn in a sterilized flask and the air excluded. We have the experiment for students and it assists them to see that the souring and curdling of milk are due to germs which gain access after the milk leaves the udder of the cow, not after it leaves the teat of the cow, but after it leaves the udder of the cow. We find in the teat of the cow different germs. We found some germs up there that did not belong there, and we do not see how they got there. Instead of washing the udder we surround it with one of the patent appliances that keeps the manure off.

Now I am a practical milk man and not a doctor. At some of the stables which I have visited in the vicinity of Detroit and its suburb Grand Rapids, if you recommended them to wash the udders you would be simply, not adding fuel to the fire because water is not a fuel, but you would change from the devil to the deep sea. You must not let the fecal matter adhere to the udder of the cow. You must use proper appliances to keep the cow clean. Just as certain as the milk man keeps the cows in such filthy condition that he has to clean the udder, just so sure will he be too filthy to trust to wash them. I recommend that he brush his cows dry and use the proper stable fixtures to prevent the soiling of the udders by the dung and urine.

*Dr. Mills*—I wish to bring up the subject of legislation in reference to this matter of handling milk. I would like to know what the present state of the law is in regard to this matter.



*Mr. Wells*—I know of no recent legislation in regard to the matter so far as protecting human beings is concerned. Legislation only goes to the extent of protecting animals.

*Mr. Woodman*—I desire to ask the doctor if the presence of the germs of tuberculosis in milk can be definitely ascertained by a microscopical examination.

*Dr. Vaughan*—No, not always. The finding of the germ of tuberculosis in milk is not always an easy matter, and if it is not taking too much time I would like to bring up one point here to ask Professor Smith about. We use the centrifugal machine for isolating germs from urine, milk, blood, etc. Now I should not have had any hesitancy had I been asked a year ago to swear that cream separated by the centripetal process contained fewer germs than the milk, but it is not true. The cream will contain more germs as a rule than the milk, and sometimes the cream will contain more germs than the slime at the bottom of the milk. Now the microscopical demonstration of the tuberculosis germ in milk is not absolute. The only way that you can be certain about it is to inoculate guinea pigs, and of course in order to be absolutely certain you have got to inoculate a goodly number of guinea pigs. The tubercle germ does go to the bottom better than most of the other germs, but I suppose it is probably a little heavier than most of the germs. I am surprised at the large number of germs in the cream.

*Mr. Hinds*—You were going to ask Professor Smith something.

*Dr. Vaughan*—I was going to ask about the number of germs in the cream.

*Prof. Smith*—We find that the number of germs is vastly greater in the cream than in the skimmed milk. Some of you will probably remember a case of feeding some hogs in Northern Germany, and how singularly fatal the disease was there. I do not know that we have found more germs in the cream than we have in the separator slime.

You said that you would mention two or three facts concerning the growth of this germ. I simply have in my notes one, that it grows on any kind of vegetable, and hence the danger from decaying vegetables.

*Dr. Vaughan*—I must have overlooked the others. It does not grow below 25 degrees C.; the maximum growth is 37 degrees C. Another thing was the readiness with which the germ is killed. In the sterilizer the temperature at 100 degrees C. destroys the germ immediately.

*Mr. Hinds*—I desire to say for the information of Dr. Mills who asks the question that the Live Stock Sanitary Laws of this State are the same that they were when this association met here two years ago. The last Legislature made no change whatever in these laws.

While upon my feet permit me to say that there is a great deal of misapprehension among milk producers and consumers as to the ability of the scientist to determine the presence of tuberculosis in a cow by the examination of the milk of the animal, either scientifically or otherwise. Dr. Vaughan has answered that proposition in general terms, but the practical man will see the difficulty of relying upon that test. For instance, if I brought the experienced bacteriologist a sample of milk from a cow suffering from tuberculosis generalized, or even specialized to an affection of the udder, on some days he might be unable to find the bacilli of the disease while on other occasions he might find the



samples from the same cow teeming with the germs of disease. Therefore, to have any safety at all from that kind of a test, it would need to be kept up almost constantly. There is a common theory even among intelligent people that if they should send a single sample of their milk here to the University or to some other bacteriological laboratory, the health of their cattle might be at once determined. Of course that understanding of the matter should be discouraged.

I also desire to say here and right now in defense of the dairy cow of Michigan that she is much less affected with tuberculosis than most people are led to believe. Now, as a matter of fact, the laws of this State do not contemplate that this commission shall go out and examine any domestic animal unless the same or the herd or the flock to which it belongs are believed to be affected with some contagious or infectious disease of a malignant character. Now, in the course of events, we have applied the tuberculin test to cattle from the south line of the State to the shores of Lake Superior. In no case has the test been applied except where some animal or animals in the herd showed marked indications upon physical examination, of being affected with the contagious disease called tuberculosis. Among all the animals tested to date, less than twelve per cent have showed the presence of the disease by reaction. Substantially all of the cattle upon which the tuberculin has reacted have been slaughtered and the lesions of the disease have been found upon post mortem in every instance. I think I said here in this hall two years ago that in my judgment less than one per cent of the cattle stock of Michigan was affected with tuberculosis. This was of course a personal opinion of my own after extensive opportunities for observation and yet I am not disposed to change the estimate after time has given me much additional information. I do not mean to be understood as expressing the opinion that less than one per cent of the milch cows of the State are affected with this disease, but that taking the cattle of the State as they run, a very small percentage are so affected. In herds that have probably been affected for some time and that have been bred along lines that did not require the introduction of much new blood, we find a very large percentage affected—say fifty or even seventy-five per cent responding to the test. Now the law of the survival of the fittest takes care that this disease does not spread in many cases. I do not believe that any of these herds would long be so affected with tuberculosis if they were turned loose in natural conditions to battle with the elements. The very inclemency of the weather would kill off the diseased ones before they had seriously spread the malady. Where we find the disease flourishing and doing most damage is in herds kept in bank barns or other close and warm quarters where it becomes possible to keep the diseased animals nurtured and alive too long to the infinite damage of the balance of the herd.

*President Wells*—We are glad to hear from Mr. Hinds on this subject. If there is no more discussion upon the subject of Professor Vaughan's talk, we will proceed to the next.